SUGGESTIONS

ON

TOWN SEWAGE

AND ITS

APPLICATION TO LAND BY GRAVITATION.

BY

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TOWN SEWAGE.

The Sewage of towns, the utilisation of Sewage, and the purification of polluted streams, are subjects which now attract an interest which their importance to public health and comfort imperatively calls for.

A Town, for the convenience, comfort, and health of its inhabitants, obtains its water supplies at great cost, and at the like, is intersected and riddled with drainage of every conceivable variety, from the clumsy old fashioned combination of sewer and cesspool in one, to the well shaped sanitary pipe of more recent introduction. The daily influx and outflow of the

artificial supply, the land drainage of the Town's area, and the rainfalls, are studiously collected into underground streams, pitched down their greatest falls, united in large mains at low levels, and finally discharged into a neighbouring stream. Here however it is not done with. This the Thames has shewn, and this, almost every river in England shows more or less, especially where towns follow each other along the line of a continuous valley watered by one stream. The Calder in Yorkshire, now the most polluted river in England, is eminently an instance of a once fair stream being converted into a foul sewer. Far otherwise is it now, from what it was when the topographical historian Whitaker headed his article on the vale of Calder with these words—

> "Castleford Women must needs be fair
> Because they wash both in Calder and Aire."

How often is it not manifest that the contaminated water of one town passes along the course of a sluggish stream depositing the substances held in suspension upon an already too full bed, and carrying forward most of its soluble admixtures to the water supply of another town lower down the stream? These evils, gradually growing with the growth of town population and the increase of arts and manufactures, manifest their baneful influences in various forms, according

to peculiar and local circumstances, but their cumulative action on human health and comforts must continue to be a serious consideration, increasing in importance in a greater ratio even than the increase of town population. A small country town with a population of two or three thousand people, may be a healthy place without systematic sewerage, but if the same town swells to a population of 10,000 it will become very unhealthy unless systematic house drainage be adopted.

The history of town Sewerage displays to a great degree the principles of self help regardless of what may be the effect on others. Thus, every species of fluid refuse and filth is carefully collected to some stream, or natural outfall, whereby the town gets rid of it—but what happens after that is no concern of theirs—the lowest level gives the greatest fall, and so the town is freed.

If the continuance of this system is essential to proper town drainage, we must be content to sit down with poisoned rivers, as an unavoidable evil consequent upon the growth of population on small areas. But is its continuance essential? It can clearly be shewn that it is not, and that the Sewage of most towns, and the bulk of it from all towns, may reach the outfall rivers as pure as the water which first entered for

their service. The utilisation of Sewage, by its conveyance upon and through land, is undoubtedly the only way of its purification; the usual practice of throwing it at once into the lowest level of a town's area, has suggested the necessity of pumping it up for application to the land. This necessity however is at once met by the immense cost of pumping apparatus on a large scale; by the extreme difficulty of pumping all supplies that may be presented, especially when they greatly exceed the average, as in times of flood, and by the great cost compared with the value of the material operated upon—the expense of pumping per gallon being certain, the value of Sewage per gallon being uncertain—the cost of the one may be small, but it can be measured, the value of the other is immeasurably small.

There are probably no towns where the great bulk of the Sewage may not be disposed of by gravitation, if properly applied, and there are comparatively speaking few, where the whole of it cannot be so disposed of. It is not at all necessary to instance Edinburgh, or other places considerably elevated above the land that surrounds them. The natural inclination of every valley is usually much greater than the positive requirements for the fall of water, the evil lies not in the want of fall, but in the want of system. It may

well be asked why should the Sewage of St. John's Wood, of Camden Town, of Oxford Street, or any other of the higher parts of London have been pitched down to a level below high water mark, thence to be disposed of by miles of costly drains through the lowest level of the London bason? while there are poor sands, and poor clays, in the neighbourhood of London, which might have been reached by much of the Sewage water, if only, the disposal of the Sewage had, in the first instance, received its fair share of attention in conjunction with the arrangements for clearing houses and streets. Provincial Towns are watching the experience of the Metropolis, and waiting to see the results of the skill, the science, and the expenditure, that have been so freely brought to bear upon its re-drainage, and they will see that the combination of these has produced great intermural improvements, but that the disposal of the Sewage matter is a difficulty in respect to which London as yet affords no solution. No other town can yield a like quantity of fluid refuse for the reclamation of wastes, and few can find a no-man's-land over which to spread it; thus, the Metropolis will only solve the first half of the difficulty, leaving an equally important half to be provided for in some other way than can be gathered from its experience.

So long as the mere riddance of Sewage was the only object to be attained, the greatest fall would seem the best course to adopt, but then, in tidal rivers, there follows the backing up of Sewage, at every tide, to the town whence it has come; or in others, the accumulation of the solid matter in some sluggish river, there to be precipitated and decomposed, and to waft back its gaseous impurities upon the air of the town whence it emanated; or further, to be more or less carried down towards some other town, the water supply of which is taken from the stream thus polluted. In the latter case, the difference in level may be, and often is, considerable—sufficient, at any rate, to have allowed all the Sewage of the upper town to have been passed over and drained through land, and thus perfectly purified, before it reached the water supply of the lower one.

Water requires no great fall to flow, and as an increase in its velocity occasions a diminution in its bulk, or sectional area, so a decreased flow can be met by a properly proportioned increase in its sectional area, or in other words in the capacity of its carrier. When Sewage water has passed from the houses and streets of any part of a town, there is no necessity for giving it a very rapid fall in order to get rid of it, a moderate fall will do just as well, and so long as it is

continued in motion throughout its depth, whether slow or fast, Sewage will remain much in the same intermixed state as it was when it entered the sewers, that is to say, decomposition and its results in noxious gases, will not take effect with their natural vigor, until the rapidity of the stream has begun to subside, or the motion to cease. In towns where much manufacture goes on, there will be decomposition of refuse chemical substances under any circumstances, as soon as these come together—and as much so in the minor, as in the Main Sewers—and this can never be prevented. But, generally speaking, the more injurious gases, it may be submitted, do not emanate from these combinations, but from the decomposition of animal and vegetable refuse with each other, and with these, when all get into a quiescent state, as they do in the bed of a sluggish stream.

It has been argued that the time has not arrived for the utilisation of Sewage upon land, because the farmers have yet to be convinced that it will be worth their while to take it, when brought alongside their fields, and on this they are supposed not to be over sanguine. If however, towns are to postpone the disposal of Sewage, and savation of rivers from pollution, till a change comes over the agricultural mind, they may wait till doomsday. It is one thing to bring the

Sewage alongside a portion of land capable of being irrigated, and it is another thing to lay it on the land; when the same parties who convey out the Sewage provide the methods of its disposal—when, in fact, they take the whole responsibility, or take a proper share in that responsibility, upon themselves, then, and not till then, will the farmers take it up, employ it, and pay rent for it. The formation of a carrier for irrigation is but one item in the cost of flood meadow preparations, that cost is beyond the compass of the tenant farmer, it is beyond that of many a landowner, and, where extended to a large scale, it is only within the compass of commercial bodies, especially of such as have a double purpose to serve in its employment. If powers were conferred on Local Commissioners of Sewers, to rent, or to buy, to let, or to sell, lands adapted for irrigation, with the necessary powers of conveyance to and through such lands and other lands, and powers also to lay off, and operate upon these, and upon other lands, in the manner requisite, and to co-operate with owners of land in these undertakings, a few years would suffice for the utilisation of the Sewage of many towns, and the clearance and purification of many of the streams and rivers. In the meantime, large supplies of fresh grass, so much needed in Towns, would be near at hand, while the value of the resulting

produce would generally yield a proper interest on the capital invested.

Many instances may be seen of the waters of a stream that have passed through a town and received its Sewage, being diverted upon low lying meadow land, producing beneficial results, but these are not the situations specially suitable for irrigation. In the first place, they are generally rich by nature, and the less in need of additions of this kind to their quality, they tend to grow the coarse grasses, and irrigation increases this tendency ; their outfall is also frequently defective, and thus the water is apt to remain too long upon, or near their surface ; whereas the maximum point of profit in irrigation is clearly shown to be obtained by a free supply, and as free a command of outfall ; but besides this, the water passing along a sluggish stream, has laid down a considerable portion of its floating matter before it reaches the meadows, so, it is only at flood times that these get coated with solid Sewage matter ; under all ordinary circumstances, this remains in the stream, and specially so, when the water is low, and consequently contains a greater proportion of impurities, which then become deposited in its bed, and are only partially removed by subsequent floods.

But whatever may be the profits of irrigation in low situations, despite their drawbacks, the advantages

are manyfold when it can be brought to bear upon uplands, and sloping land; particularly upon such as are of a light and sandy nature. Here, irrigation of any kind is valuable, and much more so, if the water be enriched by the substances that compose town sewage. The irrigation of low lying situations may admit of a doubt, but the irrigation of these never can; the lighter and the drier the lands, the more will be the comparative value; in light uplands the outflow can at all times be proportioned to the supply, the purification of the water through drainage can always be secured, and the supply can never be in excess. The same remark applies to all uplands, only that the stronger or less porous the land, the greater should be the area rendered applicable to irrigation, and *vice versa*.

The conveyance of Sewage to uplands by gravitation is undoubtedly the most effective way of disposing of it, and there are few towns that would not admit of an upper, a middle, and a lower sewage discharge, if such were necessary. The actual fall requisite for conveying out Sewage water through the medium of carriers, freed from the various obstructions which are presented in a tortuous stream, is but very small, very much less than the ordinary natural incline of valley land, there is therefore a power at disposal, of keeping the Sewage flow at the least possible fall on its exit

from a town or section. But it may be urged that Sewage water contains a considerable mass of matter held in suspension, which in a stream of small velocity would tend to deposit, and so choke the carriers; this difficulty however can be overcome by keeping the water in constant motion by mechanical appliances. It must be within the observation of everyone that very muddy water can be kept in flow by a slight stirring. The power that would be called into action to keep the solid Sewage matter in mechanical suspension in water would be but small, compared with any pumping power to raise Sewage from a low level to one at which it could be utilised. No practical obstacle need be apprehended in discharging Sewage, thus assisted, at a much smaller fall than the natural inclination of land presents, nor any, in keeping the suspended matter in motion, and in flow, along the lines of intermediate carriers, between the sewers of a town and land that may be reached for irrigation.

The Sewage water from the Town of Mansfield in Nottinghamshire, and the small stream which passes through it, are most effectively employed and purified, under circumstances which fully bear out several of the foregoing remarks. The natural fall of the valley is less than exists in many other districts; the entire fall of the stream, thus employed, from the upper side

of Mansfield to 8 miles below it, and beyond the furthest point of the water meadows, is only 200 feet, or 23 feet per mile. The geographie area over whieh the stream eolleets by rainfall and springs before it reaches Mansfield, is about 8 square miles, or about 5,000 aeres. It rises in the adjoining Parish of Sutton in Ashfield, at an extreme distanee of about 4 miles from Mansfield, it reeeives whatever Sewage the Village of Sutton may yield, and in its passage downwards, through Mansfield and its environs, takes up the Sewage of that town, and goes on with a gentle fall, for a distanee of nearly one mile, where it is intereepted, and beeomes the carrier for a series of flood meadows. This work of utilisation was performed by the late Duke of Portland about the year 1816, and has been very clearly and eoncisely deseribed by the Speaker of the House of Commons, in the fourth part, of the first volume, of the Journal of the Royal Agrieultural Society (1840.) The article to which I refer, is aeeompanied by diagrams, showing the natural fall of the land, and the height to which the ehannel or earrier is kept, to get the utmost use of the water, and with seetions, illustrating the manner in which the water is conduеted over the sloping land between the earrier and the natural outfall; but its principal merit eonsists in the demonstration of the

monied value of the Sewage and other water, applied to a very poor and sterile tract of sand and peat, the original produce value of which was all but nil, the improved produce value, on a very fair estimate of it, being from £11 to £12 per acre per annum, and yielding a return of $9\frac{1}{4}$ per cent. upon the capital invested. The per acreage cost of this work was large, but the per acreage profit is large also, large enough to have repaid the capital invested years ago, leaving nothing but profit for the present and the future. One of the most valuable features of this example is, the evidence it affords, at the present day, that the process is not an exhausting one, there is no digression in produce value; the 300 acres of the Duke of Portland's water meadows, and 103 acres subsequently irrigated from the same stream by the late Earl Manvers, have gone on from their formation to the present time, yielding every year a large amount of grass for mowing green, of hay, of beef, mutton, and wool, upon land which if left to itself, would be all but sterile. This irrigation commences at a distance of $2\frac{3}{4}$ miles from Mansfield, and extends for $5\frac{1}{2}$ miles along the course of a narrow valley; and in this distance all the Sewage water that the town yields, has flown upon, and been drained through, some one or more of these meadows, has parted with its impurities, has returned

to the river as pure as all ordinary streams are which flow from land only. Such is the use that one small stream, aided by the Sewage of a comparatively speaking small country town, can be made to produce by judicious employment of gravitation, the measure of which may be stated as thus ;—a drainage area of about 8 square miles above Mansfield, and about 14 square miles down the course of the stream, and a population somewhat under 18,000, are sufficient for the profitable irrigation of 403 acres of land, converting them, from all but sterility, into meadows of great value in themselves, besides yielding much additional manure to the cultivated lands around them, by the fodder consumed in the farm yards, which, in its turn, produces so much more corn and green crops. The full value of these advantages may not be estimated with any positive certainty, but they are not the less real for all that. The produce value of the meadows, taken by themselves, varies inversely with their distance from Mansfield, those nearest the source of Sewage being much the most productive ; and as, in the whole course of the irrigations, there are four levels of carriers, two in the upper set of meadows, and two in the lower, it may well be conceived, that the third and fourth waterings are not of equal value to the first and second.

It must be very evident that the value of Sewage

increases in proportion to the population that produces it, while the area over which it may be profitably distributed, depends in a great degree upon the watershed area, or drainage district, gathering water that can be united with the Sewage. It may be fairly argued that if the town of Mansfield and its neighbourhood, can within a few miles have all its waste water purified, yielding such valuable results in the process, what might not many of the larger manufacturing Towns do, with their dense population, for the benefit of the land which surrounds them, as well as the health and comfort of their inhabitants. There are few Towns that do not present ample fall for the disposal of their Sewage by gravitation, and ample scope for its profitable employment upon land.

Whatever may be the rules that experience or custom has laid down for the inclines of Sewers, as necessary for the clearance of such as cannot be easily reached, and in which the average quantity of Sewage is at most times small; these rules need not apply to Main Sewers and large accumulations of Sewage; the fall may, and probably ought to be considerable on leaving a house, a court, or a gulley-shot; but when the bulk is increased by several of these tributaries coming together, their cumulative action creates a new velocity which will overcome a great diminution in fall;

and this is a most important point to keep fully in view in discharging Sewage for utilisation and purification, because the higher the discharging carriers can be kept, the greater will be the command over land to be operated upon the main carriers must increase in sectional area as they diminish in fall, as well to compensate for that diminution, as to be prepared to carry off the extra water of an unusual or excessive rain, but this is a contingency which calculation and contrivance can perfectly control.

The minimum fall that water in bulk requires, when passing over an unobstructed bed, is infinitely less than the natural incline of the country generally, as is illustrated in the fen and marsh drainages; and when once Sewage water is brought together in bulk, it may, like the carrier of the Duke of Portland's meadows, be kept up at a high level and have a very slight incline. In that instance, the natural fall in the Valley is 200 feet upon a distance of $8\frac{3}{4}$ miles, or 23 feet per mile, being an incline of 1 in 231, whereas the carrier for the first $2\frac{1}{2}$ miles has only about 9 inches in the mile, and for a further distance of $2\frac{3}{4}$ miles the fall appears (as stated in the article already alluded to), to be only 3 inches in the mile, and with this slight fall, there is no material accumula-

tion of solid matter, nor any that cannot be controlled by a moderate labour outlay.

In adopting a system such as is here described some length of carrier might in many instances be requisite before land were met with, sufficiently removed from population, and otherwise adapted for irrigation, and there would be a tendency to deposit solid matter carried down in the Sewage. To meet this contingency, two simple methods might be had recourse to, first the heavy materials such as stones, sand, &c., could be deposited in chambers prepared for them, and the lighter material, might, by the appliances already alluded to be kept in motion, and so forced to flow on with the water, until it were brought under the influence of the outrush of the flood sluices. A motion of this description calls for mechanical contrivance of the simplest kind, and would be effected by the appliance of a low power.

The theorem of deodorisation of Sewage has been tested, and has failed; that of precipitation has failed also; and filtration through the soil, or in other words utilisation is the only alternative that remains. For the performance of this there are but two courses, first to adopt the old method of making the water run down hill as fast as possible, and when there, applying to it expensive mechanical power for pumping, and the

costly system of iron piping for reconveyance to a higher level, and when so conveyed, the after expense, and a serious one, of even disposal over uneven land, and this, not possibly of the whole Sewage, but only of the average flow ; or secondly, to intercept the sewage of towns and their environs, taking in large areas if possible, in sections, or water-sheds, and to convey it forward through main carriers, and spreading it by minor ones, over land prepared by requisite levelling, and effectual under drainage. That every particle of Sewage matter, and all the substances that the water held in solution, may, under proper management, be deposited and absorbed, has been so clearly proved by Professor Way, and Baron Liebig, that no doubt can possibly remain on this point, that if Sewage can be spread over land of sufficient area, and filtered through it, pure water is all that it will return to the rivers.

The examples given, and the allusions made, in the foregoing, have related to grass land, being that upon which there is the greater experience ; but grass is by no means an indispensable recipient of Sewage water; arable land, under certain circumstances would be equally benefitted by irrigation in Autumn and Winter when the grass needs it least; and the grass land would be most benefitted by its employment in Spring and

Summer, when the arable fields are occupied in producing crops.

Before comprehensive arrangements for the disposal of Sewage, in the manner here described, could be brought about, powers must be conferred for which adequate provisions do not appear to exist, or if existing, are not generally known and understood. The local Government Acts point to the disposal of Sewage; but do they equally point to, or provide for, its utilisation by those who have the disposal of it? Provisions exist for the conveyance of Sewage beyond the boundaries of a town, and for its distribution upon land, and compulsory powers are conferred for the acquisition of land for this purpose. But with all these, and other provisoes, is it clear that exclusive ownership in Sewage is vested in any corporate body after it has flown beyond the bounds of their customary jurisdiction; or that the sale, or distribution over land, would justify such a body in charging, by assessment upon Town property, their outlay in works of irrigation? which, in addition to the cost of conveying out the Sewage, implies the cost of forming submain and minor carriers, sloping and levelling uneven surfaces to secure uniform distribution, effectual under-drainage, and certain acts of husbandry in preparing and seeding down the land; in fact, of doing all the engineering

and agricultural operations, which, from first to last constitute the formation of successful and profitable water meadows. Under the most favourable circumstances, these works are expensive, but if the powers of distribution fall short of providing for these, they are inoperative.

If land is to be the medium for the disposal of Sewage, and the appropriation and purification of its water—and there seems no other—every facility consistent with a due regard to existing rights and interests should be afforded to give effect to this object. The provisions of the various Land Improvement Acts may well be brought to bear upon that portion of the expenditure which would be incurred in adapting the surface of land to the reception of Sewage. Under these Acts, a landowner may charge his estate with the cost of improvements of a permanent nature, and repay the principal sum borrowed, and the interest, by a fixed annual rent charge, spread over a given number of years. If a co-operative system were organised, under which Commissioners of Sewers were empowered to supplement any deficiency which might arise in the event of the results being at any time only partially profitable, or falling short of the created charge upon the land, one of the great obstacles to utilisation of Sewage, by private individuals, viz : its cost, would be

removed, thus, rates of Towns being made answerable for their Sewerage works, and land charged with a cost not exceeding its actual improvement value, the capital expended would be secured upon each interest, in proportion to the advantage that each derived from their united undertakings.

WELLOW, NEWARK.

April, 1865.

APPENDIX

By the kind permission of the writer, the following quotations are extracted from the article in the Royal Agricultural Society's Journal, alluded to in the foregoing, which appear to bear strongly upon some of the points in the Sewage question which attract attention to the present time.

In reference to the original condition and value of the land converted into Water Meadows by the late Duke of Portland, the Speaker writes :—

"The land immediately occupied by these meadows was in its 'wild state a line of hill-sides, covered with gorse and heather,—a 'rabbit-warren, over which a few sheep wandered—and a swampy 'valley below, set thick with hassocks and rushes, the favourite 'haunt of wild ducks and snipes; through which the little stream, 'the Maun, wound its way in its descent from the town of Mansfield.

'The whole tract, both upland and lowland, was of very little 'value. The valley was in many parts from 9 to 10 feet deep in bog, 'and almost worthless; the hill-sides varied in quality: but £80 a- 'year would have been a full rent for the 300 acres."

A general outline of the operations of preparing the land for irrigation is contained in the following :—

"The meadows were formed out of land in two different and 'most opposite states—the dry hill-side and the swampy valley. 'Each required its peculiar care, and mode of preparation. Far the 'most difficult and most expensive was the drainage of the swamp; 'and the great body of experience which has been obtained in accom- 'plishing this object would of itself afford a most valuable chapter of 'instruction to any one about to enter on a similar undertaking. 'The process pursued on the hill-sides, the soil of which is a poor 'sand, was first to stub the gorse, and to pare and burn the heather. 'The ground was then ploughed and fallowed for turnips. The 'turnips were eaten off by sheep; and the first process of rough 'levelling was then done by the spade. To lay the land in its pre- 'sent form of even and gradual slopes, much labour and care were 'necessary; hillocks were cut away, to the depth of 5 and 7 feet, 'by the spade, and carried in barrows to supply adjoining deficiencies. 'Then followed a crop of barley, and a second crop of turnips; after 'which the final and perfect levelling was completed.

'But when the water was first thrown over the ground, new and 'unforseen difficulties had to be provided against. The water found 'its way into the old rabbit-holes, and burst out in springs. All such

'unsound spots had to be dug out and rammed into firm ground. 'The slopes too, were found in some places to be too steep; in some, 'too nearly flat. The result of long experience seems to show that 'the best inclination is a fall of 10 feet in 90. Where the land is 'laid in this slope the grass is observed always to be the most forward, 'and to grow the greatest bulk. Very flat parts will not answer, 'though tried in valleys near the river, where the land is naturally 'of the best quality. The water does not get over quick enough, 'and the land is consequently starved." And again. "It has been 'said, that the difficulties of draining the boggy valley far exceeded 'the labour on the hill-sides; neither, in any case, has the result been 'so completely satisfactory. The greatest effects of water are shown 'on the driest hill-sides."

The water supplies of a town form an artificial head to its drainage, the advantages of this, where a considerable area of land is irrigated, will appear by the following quotation :—

"The supply of water has not been hitherto sufficient to control 'the effect of the seasons; indeed there is great difficulty in adjust- 'ing the quantity of stock to the land. In dry summers, when the 'river is low, the want of water is most sensibly felt. In wet 'seasons the meadows perhaps outgrow the possible consump- 'tion of the stock, and it then becomes necessary to mow a much 'greater breadth for hay. But the same wet weather which has 'caused the abundance often destroys the hay; as, from its great 'succulency, it is necessary to leave it out longer than ordinary

'meadow-hay, or even clover. The inconveniences which have been 'felt from a want of water and long droughts will be, in a great 'degree, if not entirely, remedied by the construction of a large 'reservoir of 70 acres, which has been recently formed by the Duke 'of Portland, above the Town of Mansfield, which will secure the 'means of working the mills in that Town, and of irrigating the 'meadows in dry seasons."

The additional value that the Sewage matter affords to the water of irrigation is shown in the following remarks :—

"The quality of the water is very important: soft water is the 'best; mineral waters and waters from peat mosses and bogs are 'found to be injurious. After strong rains the washings of the 'streets and sewers of the Town of Mansfield, which discharge 'themselves into the Maun, give great additional efficacy to the 'water. Mr. Tebbett compares its virtues in that state to ale; 'when, in its ordinary condition, it would not deserve a better name 'than that of small beer. It will sometimes deposit a sediment in 'one watering of the thickness of a sheet of paper."

The following remarks on the utility of the water meadows are very interesting:--

"The produce of the meadows is very great, exceeding all 'anticipation. They are farmed in the following manner:—Early in

'January, Southdown ewes, with lambs bred early for this purpose, 'are turned on the meadows. In this early season they are assisted 'with cabbages; but the ewes and lambs always do well on the 'meadows, and they appear to be particularly healthy for the lambs, 'very few dying suddenly, as will often be the case on fresh seeds. 'Ewes are put on with their lambs as they are born and gain 'strength; and in this way, from January to the end of March, and 'in some parts till much later in the spring, even till late in May 'they are devoted to ewes and lambs, feeding the lambs fat, which 'are sold at that early season at from 24s. to 30s. each. The land 'is then shut up. Some at the beginning of April; other portions 'later, in rotation. The most forward meadows will be ready for 'cutting green by about the middle of May, and will yield from 16 'to 20 good cart loads of green fodder per acre, which is carried to 'cattle in yards. In about six weeks a second crop is ready, 'which, with the allowance of time necessary to clear the first crop 'from the ground, and to apply the water; will carry this second 'cutting to the middle of July. After this an eddish will be left 'to be eaten by sheep and cattle in the autumn and early winter. 'The meadows which are first cut will frequently allow of a third 'cutting of green food, but the eddish in that case will of course be 'of less value. Speaking, therefore, of the whole range of meadows, 'to say that besides the sheep feed in the spring they will afford 'two green cuttings and an eddish, is to be rather under than above 'the mark. Some portions are allowed to stand for hay, and are 'mown after having been stocked late, early in July, yielding two 'tons to the acre, and leaving, as in the other case, an eddish for 'the early winter.

"The value, however, of these meadows cannot by any means be 'estimated by the worth of their own produce alone, however large

'that may be, their collateral benefits are so great. Requiring 'themselves no manure but the water, they afford through the cattle 'fed in yards on their produce, such a weight of manure for other 'land, that large districts have by these means been brought into 'profitable cultivation; and though the water itself runs over only 'about 300 acres, it may be said to enrich five times that extent; and 'again, by the early food they supply in the spring, stock can be 'kept off the young seeds till they have gained a head, which is a 'most important advantage on a farm, and one that, if a dry 'summer should follow can hardly be too highly appreciated."

The manner of applying the stream from Mansfield, so as to extend it over the whole area of the Meadows, is explained in the following communications:—

Extract from a letter from Charles Neale, Esqre., Agent to His Grace The Duke of Portland.

"Mansfield, Woodhouse,
'Feby. 28th, 1865."

"About sixty acres can be watered at one time, now, but in dry 'weather not more than forty acres, and during the extreme dry 'weather of last summer not more than ten acres could be irrigated 'at one time. The water that has flowed over the top meadows 'is used over again for the lower meadows. The water is usually 'kept on two days at a time, throughout the year, once in nine 'weeks, except in floods when it passes over the whole more 'frequently."

Extract from a letter from John Horncastle, Esqre., Agent to Earl Manvers.

"Thoresby Park,
'Ollerton,
'January 9th, 1865."

"Of the 103 acres of water meadows, 18 or 20 acres can be laid 'under water at one time, of course the quantity of water will 'depend on the season; if it is wet, 9 acres of the upper and 9 acres 'of the lower part can be under water altogether, but if it is a 'dry time, a less quantity is watered in squares. Upon the whole 'however, we can manage about 18 acres satisfactorily, and so com- 'plete the whole surface, by keeping the water on about two days 'and a night at a time."

Robert Hardwicke, Printer, 192, Piccadilly.